U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE

FIELD BRIEFING CHARTER

Innovation and Information Technology: The Government, University, and Industry Roles in Information Technology Research and Commercialization

Friday, May 5, 2006
2:00 p.m. – 4:00 p.m. (CDT)
Salon B, Hilton Hotel, 500 East 4th Street, Austin, Texas

1. Purpose

On Friday, May 5, 2006, the House Science Committee will hold a field briefing to examine how information technology research and development (R&D) sponsored or performed by government, industry, and universities contributes to U.S. competitiveness in the global information technology market.

2. Witnesses

Dr. Peter Freeman is the Assistant Director for Computer and Information Science and Engineering at the National Science Foundation.

Dr. Randal Goodall is the Director of External Programs at SEMATECH, an association of companies supporting pre-competitive semiconductor technology development.

Dr. Neil Iscoe is the Director of the Office of Technology Commercialization at The University of Texas at Austin.

Mr. Pike Powers is a Partner at Fulbright & Jaworski L.L.P., and chairman of the Texas Technology Initiative, which aims to retain and attract advanced technology industries, coordinate advanced technology activities, and accelerate commercialization from R&D to the marketplace.

Dr. Juan Sanchez is the Vice President for Research at The University of Texas at Austin.

3. Brief Overview

- Federal support for information technology R&D has been a key to the development of the information technology industry. The 2003 National Academy of Sciences report *Innovation in Information Technology* lists 19 areas in which federally-sponsored fundamental research underpinned the innovations that eventually became multibillion-dollar information technology industries. Examples include the Internet and the World Wide Web, parallel and relational databases, data mining, and speech recognition.

- Academic computer science research has direct relevance to the information technology industry. University research in computer science is funded by a several federal agencies, but the largest contributor is the National Science Foundation (NSF), which accounted for about 65 percent of the roughly $1.1 billion of federal funding for research performed at universities and colleges in mathematics and computer sciences in fiscal year 2004 (FY04).

- Private companies also conduct information technology R&D. While the majority of corporate R&D is focused on product and process development, companies also conduct fundamental research in their own labs and provide fiscal and in-kind support for university research and education in information technology.

- The success of the information technology R&D enterprise depends on effective partnership among government, industry, and universities. The briefing will focus on highlighting the contributions of each group, especially how all players interact in the support and utilization of university research.

4. Overarching Questions

The briefing will address the following overarching questions:

- How does the federal investment in information technology R&D promote innovation in information technology and foster the development and commercialization of new applications?
- What role does university research play in innovation in information technology? How do universities balance federal and industry support for research projects? How do companies balance support for research conducted within the company and research performed at universities? What are the barriers to use of university results in commercialization of new information technology products?
- What areas of information technology research and what type of programs should the federal government emphasize to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?

5. Background

Many of the technologies that enabled electronic commerce to take off in the 1990s are based on research initially conducted at universities and funded by federal agencies, such as NSF and the Defense Advanced Research Projects Agency (DARPA). The 2003 National Academy of Sciences report *Innovation in Information Technology*[1] lists 19 areas in which federally sponsored fundamental research underpinned the innovations that eventually became multibillion-dollar information technology industries. Examples relating to e-commerce include web browsers, search engines, cryptography methods that allow secure credit card transactions, databases to manage information and transactions, and the protocols and hardware underlying the Internet itself. Often, the unanticipated results of such research are as important as the

[1] Computer Science and Telecommunications Board, National Academies, *Innovation in Information Technology*, National Academy Press (2003), pages 6-7.

anticipated results. For example, the early research that led to e-mail and instant messaging technologies was originally done in the 1960s as part of a project examining how to share expensive computing resources among multiple simultaneous and interacting users.

These innovations have helped create an information technology sector that is credited for nearly 30 percent of real growth in the U.S. gross domestic product from 1994 to 2000 and that accounted for 29 percent of all U.S. exports in 2005.[2] In 2005, Texas companies exported $31 billion in computers and electronic products; this industry has been Texas's largest source of exports since at least 1997.[3] The military also depends heavily on the information technology sector's products to meet its critical information technology needs.

Since the pace of change in information technology products is so rapid, companies' main competitive advantage often comes from being first to market with a particular product or feature. If the U.S. research community isn't producing the ideas, or if the ideas are classified, it is less likely that U.S. companies will be the first to benefit from the research results.

Academic research also contributes to the training of the information technology workforce. Research grants support graduate students, and undergraduate and graduate computer science and engineering programs at universities produce the software developers and testers, hardware designers, and other personnel that power the computing and communications industries and the industries that depend on information technologies. (For example, automotive and manufacturing companies rely on modeling and simulation for product development and production management, and the financial services sectors utilize information technology for modeling markets and securing financial transactions.)

Federal Agencies That Support Academic Information Technology Research

University research in computer science is funded by several federal agencies, including the Department of Defense, the National Institutes of Health, the National Aeronautics and Space Administration, and the Department of Energy, but the largest contributor is NSF, which accounted for about 65 percent of the roughly $1.1 billion of federal funding for research performed at universities and colleges in mathematics and computer sciences in FY04.[4]

Coordination among the agencies primarily occurs through working groups organized under the multi-agency Networking and Information Technology Research and Development (NITRD) Program, which operates under the auspices of the White House Office of Science and Technology Policy. The total estimated federal spending on networking and information technology R&D in FY06 is $2.9 billion; this includes funding for government laboratories and industry, as well as university research. The breakdown by agency and proposed FY07 spending is outlined in Table 1.

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[2] Data from the Information Technology Industry Council.

[3] From the Business and Industry Data Center, Texas Department of Economic Development. Available on line at http://www.bidc.state.tx.us/overview/2-2te.htm.

[4] Data on support for university research is from *Academic Research and Development Expenditures: Fiscal Year 2003* (NSF 05-320), National Science Foundation, Division of Science Resources Statistics, (2005). Available on line at http://www.nsf.gov/statistics/nsf05320/.

Table 1. Estimated Federal Spending on Networking and Information Technology R&D (dollars in millions)

Agency	FY06 (Estimated)	FY07 (Requested)
Department of Defense	1053	1081
NSF	810	904
Department of Health and Human Services	562	548
Department of Energy	291	387
National Institute of Standards and Technology	39	43
National Oceanic and Atmospheric Administration	16	23
National Aeronautics and Space Administration	78	82
Environmental Protection Agency	6	6
Total	**2855**	**3074**

Areas of research supported by these agencies include supercomputing, cybersecurity, networking, software design and productivity, human-computer interaction, and workforce development issues. In general, each agency focuses on information technology research in areas relevant to its mission; for example, the Department of Health and Human Services and the National Institute of Standards and Technology are working on technologies and standards for information technology applications in health care, while the National Oceanic and Atmospheric Administration develops and implements improved weather modeling techniques.

National Science Foundation

At NSF, projects are selected for funding through a competitive, peer review process, in which NSF brings together panels of experts in a given field to review proposals anonymously. Researchers can send project proposals to NSF either in response to agency-issued requests for proposals in specific areas or as unsolicited proposals.

Computer science research at NSF is conducted almost entirely in the Computer and Information Sciences and Engineering Directorate (CISE). Relevant CISE activities include support for investigator-initiated research in all areas of computer and information science and engineering and support for the education and training of the next generation of computer scientists and engineers.

Research supported by CISE is designed to promote advances in new software, hardware, systems, and algorithms. Specific areas of research include work relevant to homeland security, such as cybersecurity, machine translation, artificial intelligence, computer vision, robotics, and techniques for information retrieval, analysis and display ("connecting the dots"); research on new supercomputing hardware and software architectures; projects to support the systematic re-design of current network systems, such as the Internet, to make them more secure and stable and able to handle more traffic; and explorations of totally new approaches to computing, such quantum and bio-computing.

At the University of Texas at Austin, NSF funds projects in a wide variety of areas, including research on improving security and robustness by building distributed services that tolerate buggy, selfish, or malicious elements on the network; modeling of wireless networks to allow the design, development, and testing of the next generation of wireless network protocols; and new techniques for mining large data sets and delivering results in a timely manner. NSF also helps support the Texas Advanced Computing Facility, a computing facility that provides information technology resources to researchers and students, including supercomputing systems, advanced scientific visualization, and massive data storage/archival systems.

Another NSF-supported program provides research experiences for undergraduates, including a program in which students from all over Texas come to the University of Texas at Austin for 10 weeks in the summer to perform research in communications applications, including networking, wireless, security, and signal processing. Particular effort is made to ensure participation by minorities and students from disadvantaged communities.

At the University of North Texas, researchers are developing a geographically distributed, secure test bed to analyze vulnerabilities in Voice over Internet Protocol (VoIP)—an increasingly popular technology that turns audio signals into digital data that can be transmitted over the Internet. The project will investigate voice spam prevention (VoIP phone systems can be spammed like email), attacks on networks and Internet resources that render them unavailable (denial of service), quality of service, and 911 service dependability.

Non-Federal Support for University Research and Development in Information Technology

The federal government is the largest source of funds for university information technology R&D. In FY03 in all fields, universities spent $40 billion on research and development, and $25 billion of that was provided by the federal government. The remainder came from institutional funds ($8 billion), state and local government ($3 billion), industry ($2 billion), and a variety of other sources ($2 billion). In FY03 in computer sciences, the overall non-federal support was $279 million, more than double the FY96 level.

Non-federal support for university programs often supports programs that supplements or expand the goals of federally funded research. An example in research is the Microelectronics Research Center at The University of Texas at Austin, which contains a mix of complementary programs, including a nanotechnology facility funded by NSF and an Advanced Materials Research Center supported by SEMATECH and the Texas Enterprise Fund (state funds). An example in education is the recently announced partnership between SEMATECH and several Texas institutions of higher education, including Austin Community College and The University of Texas at Austin. This workforce program will include development of new nanoelectronics curriculum materials and internship experiences for 160 community college, undergraduate, and graduate students.

Technology Transfer and Information Technology

The results of information technology research conducted at universities find their way into commercial products via a variety of paths. Most formally, universities can transfer technology

by protecting (via patents and copyrights) specific results of research conducted on their campuses and then licensing the new inventions to industry for commercial development. Universities also seed innovation in the information technology industry by attracting and cultivating entrepreneurial faculty, who form or support the formation of spin-off companies. In both of these mechanisms, the efficiency and ultimate success of technology transfer from the university depends not only on the federal support for research on campus, but also on federal intellectual property laws and policies and on the willingness of the venture capital community to fund technology commercialization.

Finally, a very significant, although difficult to measure, impact of university research on commercialization comes from the education mission of academic institutions. Given the rapidly changing nature of information technology, the most efficient method of technology transfer may simply be industry's hiring of students who have worked on research projects at universities; the skills of the next generation workforce informs and enables the development of the next generation technology.

Industry Research and Development in Information Technology

In 2001 in the U.S., $60 billion was spent on industrial research and development for computer and electronic products and software by companies, the federal government and others.[5] $4.5 billion of that sum was spent in Texas. While the majority of corporate R&D is focused on product and process development, companies also support some longer-term fundamental research (of the $60 billion, $1 billion was for basic research).

The fundamental, widely-disseminated research conducted at universities and often supported by the federal government complements the focused development projects undertaken in industry. However, the relationship between these two types of activities is often not linear. In the National Academy of Sciences report,[6] the R&D for the 19 areas in which federally sponsored fundamental research underpinned the innovations that eventually became multibillion-dollar information technology industries usually involved a complex history of interwoven university and industry efforts. In some cases, the original idea came from industry, but was not commercialized until federally-supported research at universities advanced the technology. In other cases, start-up companies spun off from universities were critical players, by providing that new technologies could be introduced into established markets or by being acquired by larger companies. As the National Academy of Sciences report notes, "strong research institutions are recognized as being among the most critical success factors in high-tech economic development," and it cites seven examples where the positive impact of thriving research universities can be seen, including Boston, Seattle, and Austin.[7]

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[5] Data in this paragraph is from *Research and Development in Industry: 2001* (NSF 05-305), National Science Foundation, Division of Science Resources Statistics (2005). Available on line at http://www.nsf.gov/statistics/nsf05305/.

[6] Computer Science and Telecommunications Board, National Academies, *Innovation in Information Technology*, National Academy Press (2003), pages 11-12.

[7] Computer Science and Telecommunications Board, National Academies, *Innovation in Information Technology*, National Academy Press (2003), page 20.

World Congress on Information Technology

This briefing is being held concurrently with the 15th World Congress on Information Technology (WCIT) in Austin, Texas. WCIT is a biennial summit hosted by the World Information Technology and Services Alliance in which senior executives, government officials, and futurists from over 80 countries meet to discuss the future of information technology. This year's WCIT includes a Global Impact Program, focused on privacy and security, digital access, and healthcare; an Innovation Exchange Program, focused on technology, trade, and investment; and an Innovation Exchange Exhibition.

6. Witness Questions

The witnesses were asked to address the following questions in their testimony:

Dr. Peter Freeman:

- How does the National Science Foundation (NSF) investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?
- Hose does NSF work with industry to support information technology research? How does NSF facilitate the use of the research it supports in commercialization of new information technology products?
- How do the topics and types of NSF programs in information technology research complement other agencies' programs in this area? How do they complement the focus and investments of industry research programs?

Dr. Randal Goodall:

- How does the federal investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?
- What role does university research play in innovation in information technology? How do companies balance support for research conducted within the company and research performed at universities? What are the barriers to use of university results in commercialization of new information technology products?
- What areas of information technology research and what type of programs should the federal government support to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?

Dr. Neil Iscoe:

- How does the federal investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?
- What role does university research play in innovation in information technology? What are the barriers to use of university results in commercialization of new information technology products?

- What areas of information technology research and what type of programs should the federal government support to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?

Mr. Pike Powers:

- How does government investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?
- What role does university research play in innovation in information technology? How do companies balance support for research conducted within the company and research performed at universities? What are the barriers to use of university results in commercialization of new information technology products?
- What areas of information technology research and what type of programs should government support to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?

Dr. Juan Sanchez:

- How does the federal investment in information technology research promote innovation in information technology and foster the development and commercialization of new applications?
- What role does university research play in innovation in information technology? How do universities balance federal and industry support for research projects? What are the barriers to use of university results in commercialization of new information technology products?
- What areas of information technology research and what type of programs should the federal government support to maintain U.S. competitiveness? How do these areas complement the focus and investments of industry research programs?